the fact that excitation of any one point elicited rarely more than one movement and only of one segment, *e.g.*, simple flexion of the elbow. Consequently, any sequence of movement or march was conspicuously infrequent.

Finally, the character of each movement and its localisation was recorded.

After the cortex had been removed, we proceeded to stimulate the fibres of the internal capsule, and the results obtained confirmed those obtained from the bonnet monkey, and at the same time showed the relative position of the cortical areas.

The internal capsule was exposed by removing half of one hemisphere by a horizontal section; the outlines of the basal ganglia were then transferred to paper ruled with squares of 1 millimetre, and the resulting movement obtained by stimulating each of these squares contained in the internal capsule was recorded. The movements obtained correspond generally with the results which we have in another paper presented to the Royal Society and read on December 12, 1889.

VII. "A further Note on the Influence of Bile and its Constituents on Pancreatic Digestion." By Sidney Martin, M.D., Pathologist to the Middlesex Hospital, British Medical Association Research Scholar, and Dawson Williams, M.D., Assistant Physician to the East London Hospital for Children, Shadwell. Communicated by E. A. Schäfer, F.R.S. (From the Physiological Laboratory, University College, London.) Received June 9, 1890.

Ox Bile and Pancreatic Extract.

In a previous communication* we have pointed out that in the pig the presence of bile or bile salts hastens the digestion of starch by pancreatic extract, the amount of dextrine and of sugar being considerably and proportionately increased. The same holds good for ox bile salts and extract of ox pancreas, so far at least as the increase in the amount of sugar is concerned, and for human bile and pancreatic extract (pig's). Experiments were conducted in the same manner as those with pig's secretions. In one experiment four vessels, A, B, C, D, containing 100 c.c. distilled water in which 2 grams of starch had been boiled, were taken. To B 2 per cent., and to C 4 per cent., of ox bile salts were added and dissolved. Equal quantities of glycerine extract of pancreas were added to A, B, and C,

* 'Roy. Soc. Proc.,' vol. 45, p. 358.

and the four vessels kept at a temperature of 40° C. At the end of seven minutes there was a marked difference between A and B and C in their reaction to a solution of iodine: A gave a deep blue-purple, B and C a red-purple. At the end of thirteen minutes C gave a faint red colour, B a red-purple, while A gave the same purple colour as after seven minutes. No change occurred in D. The solutions were then boiled and the amount of sugar in A, B, and C estimated as dextrose by Fehling's method:—A contained 0·526 per cent., B 0·649 per cent., and C 0·675 per cent.

The experiment was varied by using an active powdered pig's pancreatin, manufactured by Savory and Moore. Four vessels were used, each containing 50 c.c. of distilled water in which 1 gram of starch had been boiled. To B 1 per cent. and to C 2 per cent. of ox bile salts were added and dissolved. To A, B, and C, pancreatin 0·15 gram was added; D was reserved as a control. The mixture was digested for seven minutes in a water-bath at 45° C.; at the end of this time A struck a blue-purple colour with iodine, B a dirty red-purple, and C gave only a trace of red colour. The amount of dextrose was estimated by Fehling's method with the following result:—A contained 0·3846 per cent., B 0·71429 per cent., and C 0·833 per cent.

Ox bile salts and human bile have, therefore, the same property as pig's bile and bile salts; they augment the amylolytic action of the pancreatic amylopsin on starch.

Bile salts consist of a mixture, in varying proportions, of the alkaline (chiefly sodium) salts of taurocholic and glycocholic acid. In human bile, and that of most mammals, as well as in birds and amphibians, taurocholates are most abundant; in the pig, glycocholates. Experiments were therefore made separately with glycocholate and taurocholate of soda.

Taurocholate of Soda.—The salt used was a commercial product and contained some bile pigment. Four vessels, each containing 100 c.c. of distilled water in which 2 per cent. of starch had been boiled, were taken: to A 1 gram, to B 2 grams, to C 3 grams, and to D 4 grams of the taurocholate were added; 0·8 gram pancreatin was then introduced into each, and the mixture digested at a temperature of 37° for a quarter of an hour. Tested by the colour struck with solution of iodine, D had been more changed than C, C than B, and B than A. The amount of dextrose estimated by Fehling's method was A 0·869 per cent., B 1·0 per cent., C 1·05 per cent., and D 1·11 per cent. In another experiment the effect of 1 and of 3 per cent. of the taurocholate were contrasted with each other and with the effect of pancreatin alone. Digestion was continued for ten minutes at a temperature of 40—41° C., and the mixture then boiled; that containing no taurocholate contained 0·909 per cent. dextrose, that containing 1 per cent. of taurocholate contained 1·111 per cent. dextrose,

and that to which 3 per cent. of taurocholate had been added contained 1·2424 per cent. dextrose.

Glycocholic Acid.—The addition of pure glycocholic acid in the proportion of 0·5 per cent. arrested digestion of starch by pancreatin; probably because of the acidity of the mixture.

Glycocholate of Soda.—A weighed quantity of pure glycocholic acid was dissolved in distilled water and neutralised with anhydrous carbonate of sodium. Four vessels, each containing an equal quantity of distilled water in which 1 per cent. of starch had been boiled, were taken: to B 1 per cent. of glycocholic acid by weight neutralised with Na_2CO_3, and to C 2 per cent. of glycocholic acid neutralised by the same salt were added. Equal quantities of pancreatin were added to A, B, and C; D being reserved as a control. The mixtures were digested for seven minutes at 37° to 38° C. The colour struck with with iodine solution by C was then red, by B purple-red, and by A purple. Digestion was then stopped by boiling and the quantity of dextrose estimated by Fehling's method: A contained 0·357 per cent., B 0·476 per cent., C 0·588 per cent.

Glycocoll, Leucin, and Tyrosin.—Glycocholic acid is formed by the conjunction of glycocoll and cholalic acid, glycocoll itself being amido-acetic acid. Leucin and tyrosin, the end-products of pancreatic digestion, are also amido-acids, leucin being amido-caproic acid, and tyrosin, oxyphenyl-amido-propionic acid. Glycocoll was found to be without any effect upon the pancreatic digestion of starch.

Leucin appeared to interfere to some extent with pancreatic digestion of starch; thus, in one experiment, in which 0·5 per cent. of pure leucin was added to a starch mixture and digested with pancreatin for twelve minutes, the amount of sugar estimated as dextrose was 0·526 per cent., while the amount in a similar mixture digested for the same time without leucin was 0·645 per cent.

Tyrosin also appeared to interfere slightly with pancreatic digestion of starch. Thus, in one experiment three vessels were taken, each containing 100 c.c. of distilled water in which 1 gram of starch had been boiled; to flask B 0·05 gram of pure tyrosin and to flask C 0·1 gram tyrosin were added; the three mixtures—A, to which no tyrosin was added, B, and C—were then digested for nine minutes with equal quantities of pancreatin. At the end of five minutes the colour struck with iodine solution varied, A giving a reddish-purple, C and D a bluish-purple; at the end of eight minutes the colour with A was almost pure red, with B and C still a bluish-purple. The quantity of sugar estimated as dextrose by Fehling's method was as follows:—A 0·383 per cent., B 0·345 per cent., and C 0·333 per cent.

Carbonate of Sodium.—Carbonate of sodium, when present in the proportion of 0·25 per cent. and over, retards pancreatic digestion of

starch. By experiments conducted as those above detailed, we have found that this retardation occurs also in the presence of bile salts, although it is not so great as with the carbonate alone. In one experiment four vessels were taken, each containing distilled water in which 2 per cent. starch had been boiled, and 1 per cent. bile salts subsequently added and dissolved, to B 0·25 per cent. Na_2CO_3, to C 0·5 per cent. Na_2CO_3, and to D 1 per cent. Na_2CO_3. The mixtures were digested with equal quantities of pancreatin for nine minutes at 39° C., boiled, and neutralised. The amount of dextrose as estimated by Fehling's method, was :—In A 0·83 per cent.; in B 0·55 per cent.; in C 0·492 per cent.; in D 0·3773 per cent. Even in the presence of an excess of carbonate of sodium, however, the addition of bile salts does favour the progress of pancreatic digestion of starch, as shown by the following experiment. Four vessels, each containing equal quantities of distilled water in which 2 per cent. of starch had been boiled, were taken; to B and D 1 per cent. bile salts were added and dissolved, to C and D 0·5 per cent. carbonate of sodium was added and dissolved. The mixtures were digested with equal quantities of pancreatin for 11 minutes at a temperature of 37° C., and then boiled and neutralised. The amount of sugar estimated as dextrose by Fehling's method was :—

A. Pancreatin	0·695	per cent.
B. Pancreatin + bile salts	0·952	,,
C. Pancreatin + Na_2CO_3	0·208	,,
D. Pancreatin + bile salts + Na_2CO_3	0·384	,,

Digestion of Proteids in the Presence of Bile.

Experiments were also made to test the influence of bile on pancreatic proteolytic digestion.

Bile Salts.—The fluid to be digested was made by diluting egg-albumen with distilled water, agitating, neutralising with acetic acid, and straining the resultant mixture through muslin. Measured quantities of this albuminous fluid were at the time of experiment coagulated by heat and one or two drops of acetic acid; the digestion was conducted in the same vessel as coagulation was effected.

Experiment I.—Three beakers, A, B, and C, each containing 120 c.c. of diluted egg-albumen, coagulated in the manner above described, were taken, and to each was added 1 per cent. of sodic carbonate; to A 2 per cent. of bile salts of the pig was added and dissolved; to A and B 1 gram of pig's pancreatic extract rich in proteolytic ferment was added, and all three beakers placed in a warm chamber at 35° C., and digested for three hours. The albumen in A at the end of that time appeared to be much more digested than that in B; that in C was unchanged. The fluids were then rapidly boiled, to stop all

ferment action. A contained a deep yellow-coloured turbid fluid, with a slight flocculent white precipitate; B a light yellow-coloured turbid fluid with copious white precipitate. The three mixtures were then filtered through double, balanced filters, and the filter washed, first with boiling distilled water, then with boiling methylated spirit, and finally with absolute alcohol. The filters were then dried at 120° C. and weighed.

A, the fluid which contained bile salts, yielded a residue weighing 0·150 gram.

B, the fluid which did not contain bile salts, yielded a residue weighing 0·536 gram.

C, which was not digested, gave a residue weighing 1·256 grams.

Experiment II.—In this a larger proportion of bile salts was used, and digestion was conducted at a higher temperature. Equal quantities of egg-albumen diluted with distilled water were introduced into three beakers, A, B, and C, and coagulated by heat and a few drops of acetic acid; 1 per cent. of sodium carbonate was added to each, and to A 3 per cent. of pig's bile salts; to A and B 1 per cent. of pancreatic extract rich in proteolytic ferment was added, and the mixture digested at about 40° C. for three hours. The fluids were then boiled, and subsequently filtered, the precipitates being washed and dried as in Experiment I. The weights were as follows:—

A, the fluid which contained bile salts, yielded a residue weighing 0·098 gram.

B, the fluid which did not contain bile salts, yielded a residue weighing 0·665 gram.

C, the fluid which was not digested, yielded a residue weighing 1·062 grams.

Glycocholate of Soda.—The effect of glycoholate of soda appeared to be less marked than that of the bile salts as a whole. Thus, in experiments conducted in the same manner as those above described, a small portion of glycocholate of soda appeared to have the effect of slightly increasing the amount of albumen dissolved, while a somewhat larger proportion either had a slightly contrary effect or none at all. In one experiment equal quantities of albumen were taken, and glycocholic acid,* 0·5 per cent., added to one vessel (C), and 1·0 per cent. to another vessel (D), while none was added to a third vessel (B), and the three fluids were then digested with pancreatin for two hours. A fourth vessel was retained as control. The fluids were filtered through balanced filter papers, and the filter washed with distilled water, boiling methylated spirit, and absolute alcohol, and dried at 110° C.

The weights of the residues were as follows:—

* The acid was neutralised with Na_2CO_3.

A	0·625 gram.	B	0·539 gram.
C	0·514 „	D	0·541 „

These experiments show that the power of bile to hasten pancreatic digestion is not limited to amylolytic digestion, but that it is equally, if not more, marked in its influence on proteolytic digestion.

VIII. "On the Spectra of Comet *a* 1890 and the Nebula G.C. 4058." By J. NORMAN LOCKYER, F.R.S. Received June 12, 1890.

[Publication deferred.]

Presents, June 12, 1890.

Transactions:—

Dublin:—Royal Irish Academy. Transactions. Vol. XXIX. Part 13. 4to. *Dublin* 1890; "Cunningham Memoirs." No. 5. 4to. *Dublin* 1890. The Academy.

Mexico:—Sociedad Científica "Antonio Alzate." Memorias. Tomo III. Núm. 4–6. 8vo. *México* 1890. The Society.

Munich:—Königl. Bayerische Akademie der Wissenschaften. Abhandlungen (Histor. Classe). Bd. XVIII. Abth. 3. 4to. *München* 1889; Abhandlungen (Philos.-Philol. Classe). Bd. XVIII. Abth. 2. 4to. *München* 1889; Sitzungsberichte (Math.-Phys. Classe). 1889. Heft 3. 8vo. *München*; Sitzungsberichte (Philos.-Philol. Classe). 1889. Heft 1, 3. 8vo. *Munchen* 1889; Georg Simon Ohm's Wissenschaftliche Leistungen. Von Eugen Lommel. 4to. *München* 1889; Uber die historische Methode auf dem Gebiet des deutschen Civilprozessrechts. Von Julius Wilhelm v. Planck. 4to. *München* 1889; Gedächtnisrede auf Karl von Prantl. Von W. v. Christ. 4to. *München* 1889. The Academy.

Naples:—Società di Naturalisti. Bollettino. Ser. 1. Vol. IV. Fasc. 1. 8vo. *Napoli* 1890. The Society.

Palermo:—Circolo Matematico. Rendiconti. Tomo III. Fasc. 6. Tomo IV. Fasc. 1–2. 8vo. *Palermo* 1889–90. The Circolo.

Toulouse:—Faculté des Sciences. Annales. Tome III. Fasc. 1—4. 4to. *Paris* 1889. The Faculté.

Bristowe (J. S.) A Treatise on the Theory and Practice of Medicine. Seventh edition. 8vo. *London* 1890. The Author.